11 DECEMBER 1979 (FOUO 7/79) 1 OF 1

JPRS L/8807

11 December 1979

USSR Report

ENGINEERING AND EQUIPMENT

(FOUO 7/79)

FBIS FOREIGN BROADCAST INFORMATION SERVICE

FOR OFFICIAL USE ONLY

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030019-6

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

For further information on report content call (703) 351-2938 (economic); 3468 (political, sociological, military); 2726 (life sciences); 2725 (physical sciences).

JPRS L/8807

11 December 1979

USSR REPORT

ENGINEERING AND EQUIPMENT

(FOUO 7/79)

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

Photoduplications of foreign-language sources may be obtained from the Photoduplication Service, Library of Congress, Washington, D. C. 20540. Requests should provide adequate identification both as to the source and the individual article(s) desired.

CONTENTS PAGE

CONTENTS (Continued) Page

CONTENTS (Continued)

AERONAUTICAL AND SPACE

STALLED AND CONTINUOUS FLOW-AROUND OF SLENDER WINGS BY AN IDEAL FLUID

Moscow OTRYVNOYE I BEZOTRYVNOYE OBTEKANIYE TONKIKH KRYL'YEV IDEAL'NOY ZHIDKOST'YU in Russian 1978 signed to press 13 Jun 78 p 2-6

[Annotation and table of contents from book by S. M. Belotserkovskiy and M. I. Nisht, Nauka, 3000 copies, 351 pages]

[Text] The book gives a systematic presentation of the nonlinear theory of the wing and numerical methods of calculating the stalled and continuous flow-around of wings of any contour in terms of their flaps and interceptors, contour lattices, etc. on TsVM [digital computers].

The book presents general approaches based on the model of nonviscous, incompressible fluid. Two-dimensional, axisymmetrical and three-dimensional flows are examined. The book reports the results of systematic calculation of nonlinear (steady and unsteady) aerodynamic characteristics of different lifting surfaces and the characteristics of their wakes and the results of comparing them with experimental data.

The book is intended for scientific workers, engineers and graduate and undergraduate students specializing in the fields of aerodynamics, hydrodynamics, flight dynamics and aeroelasticity.

One table, 289 illustrations, 182 references.

Contents

9380
CSO:1861

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

ELECTROSTATIC ENERGY ANALYZERS FOR CHARGED PARTICLE BEAMS

Moscow ELEKTROSTATICHESKIYE ENERGOANALIZATORY DLYA PUCHKOV ZARYAZHENNYKH CHASTITS (Electrostatic Enery Analyzers for Charged Particle Beams) in Russian 1978 signed to press 7 Jun 78

/Title and table of contents of book by Vasiliy Petrovich Afanas'yev and Stella Yakovlevna Yavor, "Nauka" Publishers, 2,500 copies, 224 pages/

Table of Contents

8851
CSO: 1861

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

MOTION OF CHARGED PARTICLES IN ELECTRICAL AND MAGNETIC FIELDS

Moscow DVIZHENIYE ZARYAZHENNYKH CHASTITS V ELEKTRICHESKIKH I MAGNITNYKH POLYAKH in Russian 1978 signed to press 23 May 78 pp 2-4

[Table of contents from book by L. A. Artsimovich and S. Yu. Luk'yanov, "Nauka" Publishing House, 224 pages, 9,700 copies]

[Text] Table of Contents

11052
CSO: 1861

MARINE AND SHIPBUILDING

NEW BOOK ON SHIP VENTILATION, HEATING, SANITATION AND OTHER SPECIAL SYSTEMS

Moscow SUDOVYYE SISTEMY (Ship Systems) in Russian 1977 signed to press 16 Nov 77 pp 2, 223-224

[Annotation and table of contents from book by I. A. Chinyaev, Transport, 5000 copies, 224 pages]

[Text] The second edition of the book "The Systems of Ships" is significantly different from the first. This is due to the considerable development of ship systems in the last five years. Particularly great progress has been achieved in problems of the water supply for the vessels of the river fleet; a number of scientific research and planning and design organizations are engaged in solving these problems.

The book presents new normative materials from the regulations of the RSFSR River Register which appeared after the publication of the first edition. The material on bilge and fire-prevention systems has been updated. The chapter on "Sanitation Systems" has undergone considerable revision. New material is given on insulation of the ship's compartments and calculation of heat losses and the influx of heat across the enclosing walls. A method for determining the thermic load on the heating system is reported. In correspondence with current trends a special chapter "Air Conditioning Systems" has been written, in which in addition to a description of the basic working principles of air conditioning systems the bases for rating them are presented. The chapter "Special Systems of River Tankers" has been updated and expanded. Owing to the limited scope of the book, material of a basically descriptive nature is included in this chapter. The units of measurement of the International System of Units have been used.

The book is intended as a textbook for a course on "The Equipment and Systems of Ships" for students of shipbuilding specialties and in accordance with the curriculum existing in water transport institutes covers the section on "The Systems of Ships". It may also be used by engineering and technical workers engaged in planning and exploitation of ship systems.

104 figures, 30 tables, 32 references.

Contents

9380
CSO:1861

MARINE AND SHIPBUILDING

ENGINEERING AND DESIGN PROBLEMS OF SHIP POWER PLANTS

Leningrad TRUDY TSENTRAL'NOGO NAUCHNO-ISSLEDOVATEL'SKOGO INSTITUTA MORSKOGO FLOTA: SUDOVYYE ENERGETICHESKIYE USTANOVKI (Works of the Central Scientific Research Institute of the Maritime Fleet: Ship's Power Plants) in Russian Vol 226, 1977, signed to press 17 Aug 77 pp 2, 117

[Table of contents from the book edited by V. M. Zakachurina, Izdatel'stvo "Transport," 117 pages, 1535 copies]

CONTENTS Page

2384
CSO: 1861

NAVIGATION AND GUIDANCE SYSTEMS

USE OF GYROSCOPIC INSTRUMENTS AND SYSTEMS ON BOARD OCEAN VESSELS

Moscow PRIMENENIYE GIROSKOPICHESKIKH PRIBOROV I SISTEM NA MORSKIKH SUDAKH (Use of Gyroscopic Instruments and Systems On Board Ocean Vessels) in Russian signed to press 24 Oct 78

/Title and table of contents of book by M.M. Bogdanovich, "Transport" Publishers, 3,000 copies, 261 pages/

Table of Contents

8851
CSO: 1861

NAVIGATION AND GUIDANCE SYSTEMS

EQUILIBRATION OF GYRO-INSTRUMENT ROTATING MASSES

Leningrad YRAVNOVESHIVANIYE VRASHCHAYUSHCHIKHSYA MASS GIROPRIBOROV (Equilibration of Gyro-Instrument Rotating Masses) in Russian 1977 signed to press 18 April 1977

/Title and table of contents of book by Anatoliy Konstantinovich Skvorchevskiy and Yevgeniy Vladimirovich Promyslov, "Sudostroyeniye" Publishers, 1,700 copies, 248 pages/

Table of Contents

8851
CSO: 1861

NAVIGATION AND GUIDANCE SYSTEMS

CARDAN-RING GYROSCOPE DYNAMICS

Moscow DINAMIKA GIROSKOPA V KARDONOVOM PODVESE in Russian 1978 signed to press 7 Apr 78 pp 3-4

[Table of contents from book by D. M. Klimov and S. A. Kharlamov, "Nauka" Publishing House, 208 pages, 2,450 copies]

[Text] Table of Contents

11052
CSO: 1861

NAVIGATION AND GUIDANCE SYSTEMS

UDC: 531.768.089.68:006.065:389.1

PROVIDING STANDARDS FOR GYROSCOPIC DEVICES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 3, 1978 pp 32-33

[Article by V. A. Ivanov: "Principal Directions of Work on Metrological Support of Gyroscopic Instruments"]

[Text] The development and widespread employment of inertial navigation and control systems for air and water transport has constituted one of the greatest achievements in instrument engineering in the last 20 years. Nevertheless demands on accuracy of these systems are steadily growing, and these systems, as well as their component devices and elements, are continuing to be improved. Therefore a quite logical interest is being shown by the scientific-technical community in the problem of metrological support for this area of measurements. The range of items encompassed by this problem is quite extensive and includes development of methods and means of determining and storing reference azimuths, examination of the dynamic characteristics of gyroscopic devices over a broad range of frequencies, calibration of angular and linear accelerometers, determination of the natural frequencies of gyroscopic device components when assembled, etc. The problem of ensuring uniformity and reliability of measurements of small angular velocities of single-axis and three-axis platforms merits particular attention.

The materials published in this issue of the journal deal with a number of important problems of metrological support for inertial navigation and control devices and components, improving their accuracy, establishing the requisite standards and standard devices, testing of gyroscopic devices under operational conditions, etc.

The rapid development of air and water transport in recent decades demands a considerable improvement in the level of metrological support for inertial navigation and control systems (SINU) and devices. One must bear in mind thereby the complexity of the task, connected with the fact that these devices constitute the highest technological achievement of modern instrument engineering.

In determining the composition of standards for metrological support of SINU devices and components, one can take as a foundation already existing standards and standard devices in various areas of measurements, employed in machine tool engineering, machine building, and various branches of instrument engineering. In particular, at the All-Union Scientific Research Research Institute of Metrology they have developed US-4 units, which operate in the range 1-1000 rad/s, with an error of ~0.005%, and designed for checking and calibrating integrating motors.

In performing the task of metrological support, one must bear in mind the specific features of gyroscopic devices and accelerometers, which involve various kinds of inertial effects during the motion of bodies. The dynamics of traditional symmetrical and nonsymmetrical gyroscopes (including laser, molecular, etc) and accelerometers (angular and linear), at least in the central field of gravity forces, are described by systems of equations containing as independent parameters projections of angular velocity $\bar{\omega}$, as well as linear $\bar{a}$ and angular $\dot{\bar{\omega}}$ accelerations.

Quantities $\bar{\omega}$, $\bar{a}$, $\dot{\bar{\omega}}$ are not constant, but change on a time axis. Hence the task of reproducing angular velocities and accelerations on a dynamic basis, which presupposes development of means of determining the frequency characteristics of gyroscopes and accelerometers.

Since input values $\bar{\omega}$, $\bar{a}$, $\dot{\bar{\omega}}$ are vectors, means of determining their senses are needed. For practical purposes this reduces to developing means of determination, storage and transmission of reference azimuths, that is, is closely linked with highly-precise determination of the direction of the meridian and plane of the horizon.

Thus the essential (but not sufficient) composition of standards and highly-precise standard devices for metrological support for SINU devices and components should include the following: a unit of angular velocity standard, rad/s; a unit of angular acceleration standard, rad/s^2; a unit of linear acceleration standard, m/s^2; a system for storing and transmitting reference azimuths together with initial means of determining the plane of the horizon; standard devices for determining the dynamic characteristics of gyroscopic instruments and accelerometers (angular and linear).

At the end of 1977 USSR Gosstandart ratified state standards for units of angular velocity and angular acceleration, developed at VNIIM [All-Union Scientific Research Institute of Metrology]. The special unit of angular velocity standard is intended for operation in the range 5×10^{-8} - 2.5×10^{-4} rad/s [1]. The unit of constant angular acceleration primary standard encompasses measurements in the range 1-100 rad/s^2 [2]. The previously-established primary standard for a unit of constant linear acceleration of a solid body covers the range 0.001-200 m/s^2 [3].

Several units were developed at VNIIM to determine the freqeuncy characteristics of gyroscopic instruments. The principal piece of equipment -- a standard resonance unit -- operates in the range 1-50 Hz and 2-2000 rad/s^2 (in acceleration), with an error of not more than 0.5%. The requisite accuracy of reproduction of parameters of angular oscillations is achieved due to the employment of resonance conditions. A photoelectric autocollimator is employed to measure amplitudes, and a special interferometer to measure the harmonic distortion factor.

The principal component of the system for determination and storage of reference azimuths is a special telescope (transit instrument) and optical reference marks (miry), placed on a base of approximately 5 km. Root-mean-square error of meridian determination and storage is 0.8" (based on the results of three years of measurements).

In order to check highly accurate gyrocompasses (with an error of less than 5") one must have reference azimuths determined with an error of not more than 1", which represents a complex scientific-technical task. Without going into detail on ways to accomplish it, we shall discuss storage of reference azimuths, which is usually effected with the aid of reflectors (mirrors) attached to the walls of buildings, or autocollimators mounted on concrete bases.

Studies have shown that walls of buildings fluctuate (daily and annual fluctuations) in azimuth and relative to the plane of the horizon with an amplitude of 15-20". The principal reasons for these fluctuations are changes in temperature, which lead to nonuniformity of heating of the earth's surface layers. Excessively shallow concrete foundations fluctuate with the same amplitude. Of all the foundations studied, only a 500 ton VNIIM foundation, which is isolated, deep, and protected against external influence, had an amplitude of angular fluctuations of less than 1". Similar difficulties arise in measuring rates of gyroscope drift, since errors in determining reference azimuth in the order of 15-20" lead to errors in drift measurement in the order of 0.001' per minute.

Development of modern systems of determination, storage and transmission of reference azimuths is an important current task. Its accomplishment depends in large measure on the training of personnel capable of intelligently performing astronomical observations of celestial bodies.

We shall note other areas of work on SINU metrological support.

One important task is the development of standard means of dynamic measurement of angles with an error of 0.1-0.5", designed to be employed at manufacturing plants. We must solve the problem of measuring small oscillations (in the order of several seconds of angle) of stabilized platforms with a frequency of 100 - 1000 Hz (so-called platform "zud"). There should be fuller elaboration of methods and means of determining the natural frequencies of the assembled components of gyroscopic instruments, including after sealing. Of considerable interest are methods of measuring the gradients of temperature fields of gyroscopic instruments, etc.

We should also note that due to a lack of uniform methods of estimating small drifts of gyroscopes and gyrostabilized platforms (especially on three axes simultaneously) and means of measuring them certified by metrological bodies, accuracy tests on gyroscopic instruments manufactured from the same plans but at different plants sometimes produce substantially different results.

Even this far from complete list attests to the complexity and substantial volume of tasks in the area of metrological support for inertial navigation and control instruments and components. These problems can be resolved only with the joint efforts of USSR Gosstandart, the branches and enteprises.

BIBLIOGRAPHY

1. Ivanov, V. A.; Povarenko, A. S.; and Chistyakov, S. K. IZMERITEL'NAYA TEKHNIKA, No 1, 1968.

2. Timoshenko, A. B., et al. IZMERITEL'NAYA TEKHNIKA, No 1, 1978.

3. GOST 8.179-76. "GSI. State Primary Standard and National Testing Scheme for Devices for Measuring Constant Linear Acceleration of a Solid Body in the Range 0.001-200 m/s^2."

3024
CSO: 8144/1916

NUCLEAR ENERGY

HYDRODYNAMICS AND HEAT EXCHANGE IN NUCLEAR REACTORS

Moscow GIDRODINAMIKA I TEPLOOBMEN V VYSOKOTEMPERATURNYKH YADERNYKH REAKTORAKH S SHAROVYMI TVELAMI (Hydrodynamics and Heat Exchange In High Temperature Nuclear Reactors With Spherical Fuel Elements /TVEL/) in Russian signed to press 26 May 78

/Title and table of contents of book by R.G. Bogoyavlenskiy, "Atomizdat" Publishers, 1,750 copies, 112 pages/

Table Of Contents

8851
CSO: 1861

NUCLEAR ENERGY

THE PHYSICS OF ELEMENTARY PARTICLES AND THE ATOMIC NUCLEUS

Moscow FIZIKA ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA in Russian 1979 signed to press 7 Jun 79 p 740, 938

[Annotation and table of contents from journal, N. N. Bogolyubov, editor, Atomizdat, 1100 copies, 200 pages]

[Text] "The Physics of Elementary Particles and the Atomic Nucleus" is a survey journal of current problems in the theoretical and experimental physics of elementary particles and the atomic nucleus, problems in creating new accelerating and experimental units, problems in the atomation of analysis of experimental data. It is intended for scientific workers, graduate students, teachers in the higher educational institutions, engineers and upperclass undergraduates of physics, physico-mathematical and engineering faculties specializing in the field of nuclear physics.

The journal is published six times a year.

Contents | Page

9380
CSO:1861

NUCLEAR ENERGY

UDC 621.039.524.2.034.3

POSSIBLE CORE DESIGNS FOR THE VG-400 NUCLEAR POWER INSTALLATION

Moscow ATOMNAYA ENERGIYA in Russian No 2, Aug 79 pp 79-83

[Article by Ye. V. Komarov, F. V. Laptev, A. L. Lyubivyy, F. M. Mitenkov, O. B. Samoylov and Yu. B. Sukhachevskiy]

[Text] At present the development of high-temperature nuclear engineering is aimed at providing high-temperature heat to industrial production facilities; this includes the large-scale production of hydrogen, which can be used in the metallurgical industry for direct reduction of iron and in the chemical industry for synthesis of hydrogen fuel and as an engine fuel [1]. The combined production of high-temperature heat and electrical energy has been recognized as economically advantageous [3].

The development of industrial power production complexes with high temperature gas-cooled reactors (HTGR [VTGR]) entails the solution of a number of complex technical problems involving the production, transport and utilization of very high temperature heat, mastery of helium technology and development of new types of equipment and new materials. The development of the pilot commercial VG-400 power installation will be an important step in the solution of this problem, since the experience of developing, manufacturing and operating it will be the basis for the construction of industrial complexes.

The VG-400 installation (Fig. 1) is designed to supply high-temperature heat for the thermoelectrochemical production of hydrogen and also to produce electric power in a steam-turbine cycle. The main characteristics of the units are as follows:

Reactor power, MW	
thermal	1100
electrical	300
Hydrogen output, m^3/hour	$1 \cdot 10^5$
Helium pressure, kgf/cm^2	50
Helium temperature, °C	
on exit from reactor	950 (750)
on entry into reactor	350
Number of loops	4

Steam pressure, kgf/cm^3	175
Steam temperature, °C	535
Diameter and height of core, m	6.4; 4
Number of spherical fuel elements	$8.5 \cdot 10^5$
Average time for passage of fuel element through reactor core, years	3–4
Fuel element dimensions, mm	
sphere (diameter)	60
hexagonal prism	
distance between lateral faces	400
height	840

In the reactor block, the heat carrier in the first circuit will circulate through four loops, aided by electrical gas circulators, passing in sequence through the core, a high-temperature heat exchanger, where it will give up part of its heat to an intermediate helium circuit, and the steam generator. Heat exchange in the high-temperature heat exchanger and the steam generator will be by counterflow, and in the commercial steam superheater by direct flow.

Construction of a unit with a heat carrier temperature of 950° C will necessitate the development of new temperature-resistant materials and thus imposes real deadlines for their development. Accordingly the general design and the complement and construction of the equipment for the facility were developed to allow for the possibility of a stage-by-stage approach in its manufacture, improvement and operation.

In the first stage it will be possible to operate the unit solely for the production of electrical energy, using a heat carrier temperature of 750° at the exit from the reactor and feeding it directly into the steam generator through bypass units installed instead of high-temperature heat exchangers. The design of these bypass units will allow operation of the facility without startup of the intermediate and production circuits while shaking down the core at a high temperature.

Mastery of hydrogen production and, as needed, of the other production processes, is planned for the second stage after experience in operating the reactor has been accumulated.

The equipment of the first circuit is integrated into a prestressed reinforced concrete housing in the reactor block of the VG-400. The core, the high-temperature heat exchanger, the steam generator and the circulators are located in individual cavities in the housing which are interrconnected by horizontal gas conduits (Fig. 2). Heat insulation is installed on the inner face of the housing. The use of a concrete housing in the pilot commercial unit and integration of the equipment into it will increase its reliability and safety and will make it possible to develop a promising layout for future HTGR's. The main gas circulators are designed for cooling the unit in case of complete loss of pressure and of the external power supply.

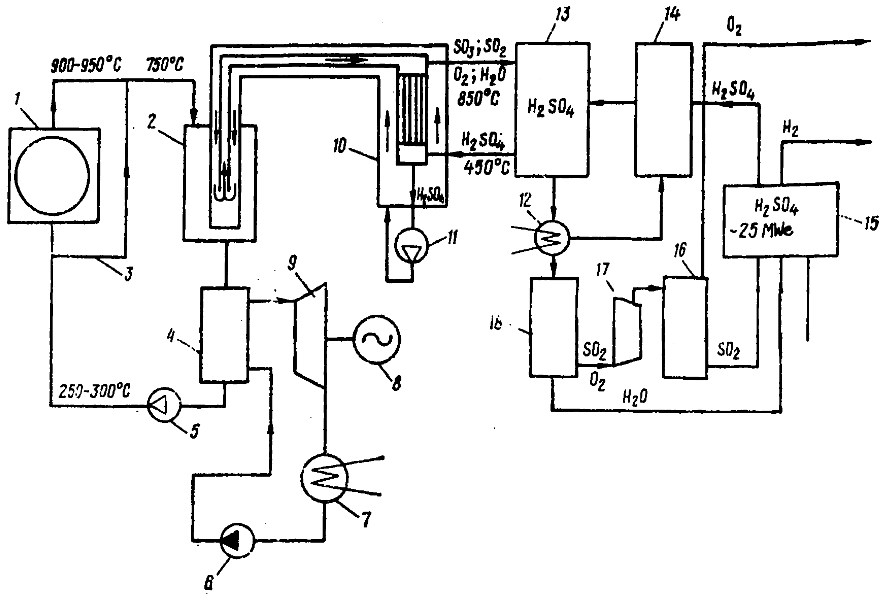

Fig. 1. General Design of the VG-400

Key:
1. Reactor
2. High-temperature intermediate heat exchanger
3. Bypass
4. Steam generator
5. Main gas circulator
6. Feed pump
7. Condensor
8. Generator
9. Turbine
10. Thermolyzer
11. Gas circulator
12. Steam generator/separator
13. Evaporator
14. Holding tank
15. Electrolyzer
16. Separator
17. Compressor
18. Separator drum

The use of a solid reloadable moderator requires that large quantities of graphite be placed in the core. Because there is no main cover to the reinforced concrete housing and because the first circuit must be kept sealed during reloading, this factor leads to special requirements for the design of the reactor and the reload complex.

Since the reactor is to be used as a source of high-temperature industrial heat, the core must heat the heat carrier to 950° with a minimum fuel temperature and also have a satisfactory fuel cycle economy, meet high reliability and repairability requirements and allow reloading of fuel in a minimum amount of time or "on the fly." In addition, the main approaches embodied in the core design must be selected with attention to the possibility of their use in developing blocks of greater individual capacity. These requirements dictate the selection

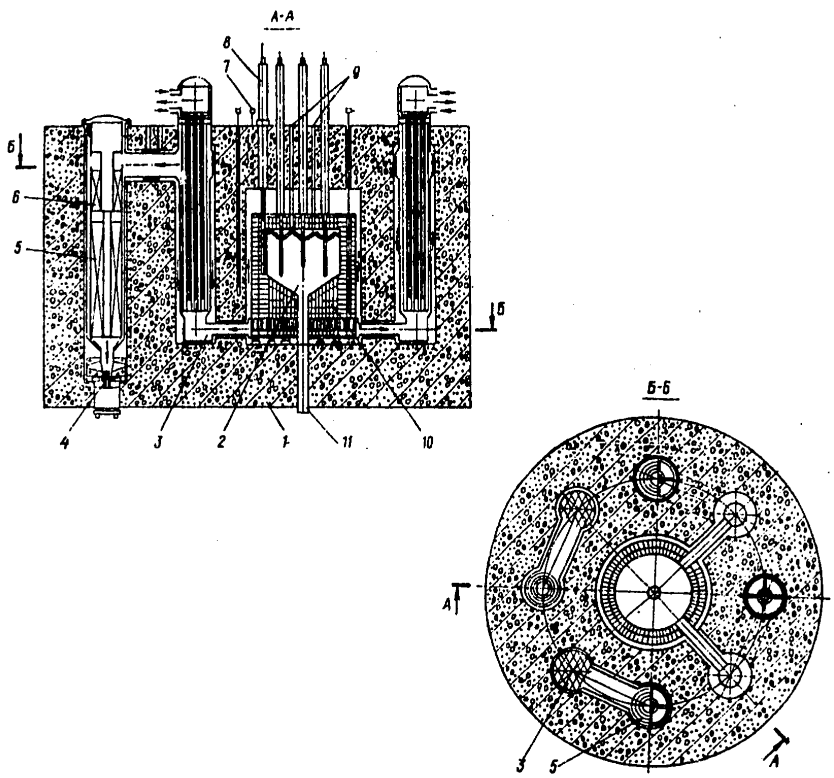

Fig. 2. The VG-400 reactor with spherical fuel elements.

Key:
1. Housing
2. Core
3. Heat exchanger
4. Gas circulator
5. Steam generator
6. Intermediate steam superheater
7. Ionization chamber suspension
8. Control system actuating mechanism
9. Loading penetrations
10. Graphite reflector
11. Unloading channel

of designs for fuel elements, arrangements for movement and distribution of the heat carrier, and organization of energy distribution and the methods and procedures for refueling.

Currently two types of cores for high temperature gas-cooled reactors are gaining wider use throughout the world: those with prismatic and those with spherical fuel elements [4]. Both conceptions were discussed for the core of the VG-400 reactor.

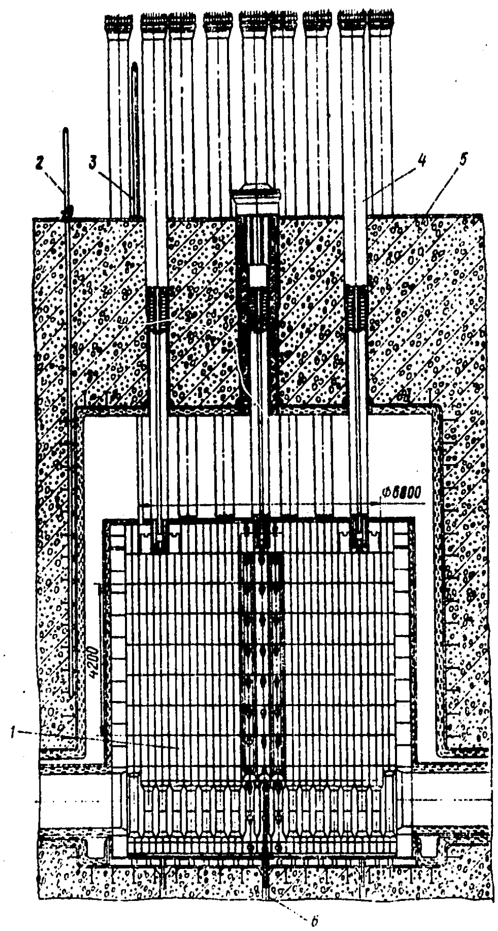

Fig. 3. The VG-400 reactor with prismatic fuel elements.

Key: 1. Core
2, 3. Startup and working ionization chambers
4. Control rods
5. Housing
6. Thermocouple

The core may be formed by columns of hexagonal graphite blocks with holes into which circular fuel elements are inserted (Fig. 3). The height of each block is 840 mm and the distance between faces 400 mm. Seven columns made of such blocks forms a modular group containing a central column for the control rod surrounded by six columns containing fuel blocks. The end row and first row of the side reflector consist of graphite blocks of similar dimensions, while the second row of the side reflector consists of stationary blocks with a toothed shape.

APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200030019-6

In order to optimize the physical parameters of the core and the capabilities of the refueling process, a fourfold refueling system was adopted for each operating period. In each cycle it is proposed to refuel a quarter of the fuel modules. Since with this method of refueling, fuel blocks of different "ages" with different powers are in the core simultaneously, the heat carrier flow rate must be regulated by means of a regulating unit installed in each module.

Attainment of an extremely high helium temperature (950° C) while limiting fuel temperature makes it necessary to organize the specific power distribution pattern in the core. For this purpose the core is divided into four subzones (two by height and two by radius), which differ in the size of their ^{235}U charge.

Each block zone is reloaded by remote control while the reactor is stopped, using a loading and unloading machine; the following operations are included: removal of the control system mechanisms, installation of the refueling machine, introduction of the gripping device, radial, angular and height guidance of the gripping device to the block in question, removal of the block, placing spent blocks in a container, gripping of a fresh block and placement of the block in the proper location using the reverse procedure.

The core can consist of a random filling of spherical fuel elements 60 mm in diameter in a cylindrical vessel bounded by side and end reflectors made of graphite (Fig. 2). The fuel elements are loaded through pipes in the upper part of the core, enter the core area by gravity and are removed through unloading openings in the lower graphite reflector. Reloading is done by means of a loading and unloading complex while the reactor is in operation. For power regulation and emergency protection of the reactor, the following rods are provided in the spherical core zone: a first group of rods is placed in channels in the side reflector, while a second is introduced directly into the spherical charge area.

The reactor operates on the principle of one-time passage of fuel elements through the core (OPAZ). Under such a system the fresh fuel elements in the upper part of the core are in relatively cold heat carrier and are at a maximum degree of energy distribution, which creates favorable conditions for decreasing the fuel temperature. Regulation of the radial distribution of heat carrier flow is more difficult in such a core, and accordingly regulation of radial energy distribution is an important problem. For this purpose a two-zone pattern of enrichment with ^{235}U is used [5]. But it is preferable to regulate energy distribution by varying the speeds [of passage through the core] of the fuel elements, which can be done by using several unloading openings or by other design measures [6].

In comparing the alternatives we have discussed, it is necessary first of all to note that the heat carrier temperature required for the pilot commercial unit can be attained in cores with either spherical or block fuel elements. The specified helium temperature (950° C) on exiting from the core can be achieved at the same fuel temperature in both core types by arrangement of the energy distribution in them. But the equipment used for this purpose differs considerably. For a prismatic core,* the system for regulating heat carrier flow rates by region is complex and insufficiently reliable in operation, while the use of four types of heat-producing assemblies (TVS) means an increased product assortment and thus creates additional difficulties for the manufacture of the blocks and operation of the installation. In a spherical core, the energy distribution can be regulated by simpler means, although a large amount of testing and experimental work will unquestionably be required in order to perfect the movement mechanics and gas dynamics of the spherical filler. The thermophysical characteristics of the spherical core which result from employment of the principle of one-time passage through the core give grounds for considering that this core type has great potential for further increases of temperature, which is particularly important when an HTGR is used in metallurgy and chemistry.

The operating characteristics of the core will depend to a considerable degree on the way in which the refueling system is controlled and on its reliability. In this respect the spherical core has certain advantages: it is reloaded while the reactor is in operation without any dismounting of equipment; the mechanisms for refueling with spherical fuel elements are simpler in design, perform identical operations and are serviced by a simpler control system than the loading and unloading machine for the prismatic core, which is large and heavy and must perform many different operations. An important shortcoming of the refueling system for the spherical core stems from the limited accessibility of its mechanisms for repair while the reactor is in operation, but this may be partly eliminated by duplicating the loading and unloading loops.

Control system mechanisms of traditional design, analogous to those used in BN-350 type reactors, can be used for the prismatic core. For this design alternative, the absorbing rods are located in special channels arranged in openings in the heat-production assemblies. Similar mechanisms may also be used in the spherical core if special pipes are installed for the control rods. But when the pipes are located inside the spherical filler, the rod diameters increase and the physical characteristics of the reactor are considerably degraded. The spherical core requires a new control-rod mechanism design with rods that can be introduced directly into the filler.

In both core design alternatives, graphite blocks are used as a reflector, which requires that they meet especially high requirements for maintenance of their dimensions and strength. The working conditions for graphite are more severe in a high temperature reactor than in other types. The temperature of the graphite blocks reaches about 1000° C with a fluence of about 10^{22} neutrons/cm^2 during the entire time of reactor operation. Under these conditions graphite blocks are subjected to large internal stresses and can undergo major changes of shape. It is possible that graphite of existing varieties will not be able to function as a reflector for the required length of time. The inner row of graphite reflectors may be replaced in the prismatic core using the standard loading and unloading machine. The lack of a similar machine for the spherical-core reactor, as well as the great complexity of replacing the reflector by means of special repair equipment, necessitates the use in the reflector of spherical-core reactors of more resistant varieties of graphite designed for the whole reactor operating time.

*["prismatic core": core with prismatic fuel elements; "spherical core": core with spherical elements]

An important factor in the selection of alternative core designs is the producibility and improvability of fuel elements. The considerable size of the heat production units in the prismatic core and the severe conditions under which they operate require careful experimental development of the heat production units under bench and reactor conditions. However, full-scale reactor testing of such heat-production units is not possible owing to their large size, which means that it is impossible to obtain sufficient confirmation of their serviceability. In this respect, the spherical fuel elements have an unquestioned advantage.

In view of the potentially great capabilities of spherical-element cores for increasing temperatures, as well as their positive qualities as regards the development and improvement of fuel elements and graphite blocks and the use of simpler assemblies and mechanisms in the refueling system and in the arrangement of energy distribution, the selection of this alternative for the pilot commercial VG-400 unit is justifiable. But attention should be directed to the necessity of developing radiation-resistant varieties of graphite and reliable control system mechanisms.

BIBLIOGRAPHY

1. Aleksandrov, A. P. KOMMUNIST No. 1, 1976, p. 63.

2. Ponomarev-Stepnoy, N. N. et al. In "Voprosy atomnoy nauki i tekhniki" [Problems of Atomic Science and Engineering], Nuclear Hydrogen Power Production series, Vol. 1 (1976), p. 5. Moscow, Izdatel'stvo IAE.

3. Mitenkov, F. M. et al. "Design Characteristics of the Pilot-Commercial High-Temperature Reactor," in "Dokl. na Vsesoyuz. seminare 'Vysokotemperaturnaya energetika'" [Reports Given at All-Union Seminar on High-Temperature Power Production], Moscow, 20-22 April 1977.

4. Bedenig, D. "Gazooklazhdayemyye vysokotemperaturnyye reaktory" [Gas-Cooled High-Temperature Reactors], Moscow, Atomizdat, 1975, p. 69.

5. Maly, V.; Schulten, R.; and Teuchert, E. ATOMWIRTSCHAFT, Vol. 4, 1972, p. 216.

6. Lohnert, G., et al. Report IAEA-SM-200/68. Julich. 1975.

Received 20 June 1978.

8480
CSO: 8144/1943

TURBINE AND ENGINE DESIGN

AIRPLANE AND HELICOPTER ENGINES

Moscow DVIGATELI SAMOLETOV I VERTOLETOV in Russian 1977 signed to press 20 Jan 77 pp 2, 341-343

[Annotation and table of contents from book by N. A. Maksimov and V. A. Sekistov, Voyenizdat, 20,000 copies, 343 pages]

[Text] The book presents in accessible form the physical fundamentals of the arrangement, operation and flight performance of modern aviation gas turbine engines used in military and civil airplanes and helicopters. It examines performance characteristics and advisable action by the flight crew in controlling a malfunctioning engine in flight.

The book is intended for the flight, technical and engineering personnel of VVS [Air Force] units; it may also be useful to the flight, technical and engineering personnel of Civil Aviation and of the DOSAAF [Voluntary Society for Cooperation With the Armed Forces] and to the students and trainees of aviation schools.

Contents Page

ARRANGEMENT, CHARACTERISTICS AND FEATURES OF THE CONTROL AND STEERING OF TVD'S [HIGH-PRESSURE TURBINES]

9380
CSO: 1861

TURBINE AND ENGINE DESIGN

LOW-VIBRATION GEARS

Minsk ZUBCHATYYE KOLESA PONIZHENNOY VIBROAKTIVNOSTI in Russian 1978 signed to press 12 Jan 77 pp 2, 119-120

[Annotation and table of contents from book by O. V. Berestnev and A. S. Savel'yevich, "Nauka and Tekhnika" publishers, 120 pages, 1850 copies]

[Text] Annotation: The prospects for developing and using low-vibration gears with flexible rim and boss couplings in transmissions are substantiated. Known standard designs are analyzed, the general principles for designing and calculating the basic parameters are formulated, and information is given on new gear component designs proposed by the authors. It is established by comparison tests that gear components of the proposed designs are superior to all-steel gears of the same size in terms of durability and that they permit a significant reduction in the level of transmission vibration. Practical recommendations are given for using low-vibration gears in vehicle transmissions. The book is intended for design engineers and scientists working on the problem of finding ways to increase gear efficiency and reduce vibration, as well as for workers at plants and research laboratories testing gear load capacity, wear resistance and vibration. Eleven tables, 40 illustrations, 55 bibliographic entries.

Table of Contents

11052
CSO: 1861

TURBINE AND ENGINE DESIGN

UDC 629. 7. 03. 004 (022)

AIRPLANE POWER PLANTS BOOK PUBLISHED

Moscow VSPOMOGATEL'NYYE SILOVYYE USTANOVKI SAMOLETOV (Auxiliary Airplane Power Plants) in Russian signed to press 17 May 77 p 2, 239-240

[Title, annotation, and table of contents from book by Nikolay Ivanovich Pavlovskiy, Izdatel'stvo "transport," 8,500 copies, 240 pages]

[Text] This book examines the design and technical operation of the TA-6A and TA-8 auxiliary power plants, which serve to start up engines of the Il-62, Tu-134A, and Tu-154 airplanes.

This book is intended for the flight and engineering-technical personnel in civil aviation. It may be used by students at higher educational institutions and those taking courses at aviation schools.

It contains 86 illustrations and 17 tables.

CONTENTS

Part III

2384
CSO: 1861

TURBINE AND ENGINE DESIGN

GAS TURBINE AVIATION ENGINE THEORY

Moscow TEORIYA AVIATSIONNYKH GAZOTURBINNYKH DVIGATELEY. CHAST 1. (Part I) in Russian 1977 signed to press 25 Oct 77 pp 311-312

[Table of contents from book (Part I) by Yu. N. Nechayev, "Mashinostroyeniye" Publishing House, 312 pages, 9000 copies]

[Text] Table of Contents

11052
CSO: 1861

END